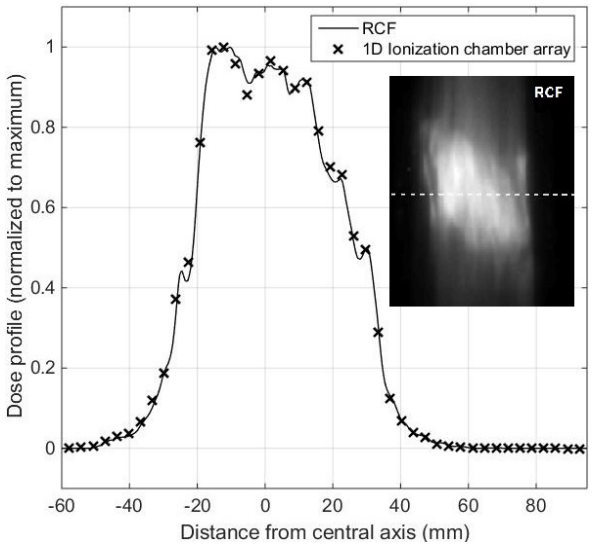

Example of patient QA: Varian Trilogy linac with HD120 MLC, VMAT delivery technique (lung tumor), 15 MV beam quality, ~6 Gy overall dose.

Conclusions: The technology has been proven to be valuable for patient plan quality assurance of complex fields through an extensive clinical investigation considering different irradiation techniques. High dosimetric performance was achieved in the verification of therapy beams due to high spatial resolution, insensitivity on dose per pulse and energy independence. The new ionization chamber technology is intended to be used in future 2D detectors.

PD-0444

Dose calibration and monitoring for radiobiological experiments with low energy proton beams

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Purpose/Objective: Low energy proton beam could be of potential interest for radiation treatments of shallow lesions due to expected higher relative biological effectiveness (RBE) and sharp dose fall-off beyond target volume. We designed and performed output measurements for RBE using EBT3 model GafChromic™ film.

Materials and Methods: Figure 1.a represents experimental setup used to measure depth dose curve (Fig.1.b) and beam output using a calibrated PTW Markus ion chamber. To improve stability of irradiation beam (26.5 MeV protons) from cyclotron CS30, an aluminum cylinder was added in front of the beam serving as a timed shutter. As beam's energy decreases with depth, measurement depth was scaled using ratio of continuous slowing down approximation (CSDA) ranges at each point. Measured signal, corrected by monitor chamber reading, was scaled by ratio of stopping powers at a given depth for water and air divided by the same ratio in Cobalt. Output was measured at 3 mm depth in the middle of plateau ahead of the Bragg peak, and PDD was normalized at the same depth. Following the TRS398 reference dosimetry protocol for proton beams, output was measured in water in terms of Gy/nC where nC is reading of the monitor chamber. Once the output was known, we calibrated EBT3 film model for doses up to 35 Gy (Fig.1.c) by irradiating film pieces in Solid Water™ at depth of 3 mm and converting depth to water. For RBE determination, attached breast cell cultures (MCF-7, MCF-12, MDA-MB-231) in 96-well plates were irradiated by the horizontal beam (Fig.1.d). Behind the plate, a piece of film was placed to monitor dose distribution during experiment. The MTT colorimetric dye assay was used to assess cell survival (proliferation inhibition) following irradiation.

Results: Depending on the cyclotron current and collimator to surface distance (CSD), outputs ranged approximately from 6.8 Gy/s (10 nA, 165 cm CSD) to 500 Gy/s (100 nA, 75 cm CSD). For each irradiated 96-well plate, a dose image was reconstructed (Fig.1.e) and then scaled by the measured PDD data. Natural Gaussian shape of the beam was used to obtain multiple dose points within the plate from single exposure. Average doses (per well) were used to construct the survival fraction (Fig.1.f). The average RBE of proton beam compared to x-ray at the 50% inhibitory dose was 1.22 (SD = 0.05), which was statistically higher (P = 0.02) than the 1.1 reported for standard proton therapy.

Conclusions: We described a radiochromic film-based dose monitoring system that can be used for colorimetric radiobiology assays with low energy proton beams. The relatively higher RBE would be promising for treatment of low laying lesions. Having a sharp dose fall-off behind the Bragg peak, high dose rate proton beam originating from a production cyclotron could further allow for dose escalation protocols in the case of superficial diseases or during intra-operative radiotherapy procedures. Supported by NSTIP 11-BIO1428-20.

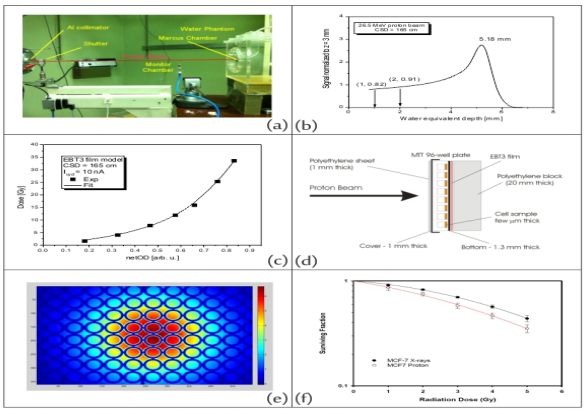

Figure 1: Dose Calibration for Radiobiological Experiments with Low Energy Proton Beams: a) experimental setup used for dosimetry measurements; b) PDD curve measured using Markus parallel-plate chamber; c) calibration curve for EBT3 model GafChromic™ film using red color channel of scanned tiff images; d) experimental setup during MTT assay irradiations; e) dose map measured with EBT3 GafChromic™ film model during MTT assay; f) comparison of survival fractions for MCF-7 breast cancer cells irradiated with 320 kVp photons and 26.5 MeV proton beam.

PD-0445

Abstract withdrawn.

PD-0446

In vivo EPID dosimetry: 3D analysis applied to prostate VMAT treatments

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Purpose/Objective: To investigate the feasibility of back-projection portal dosimetry for accurate *in vivo* 3D dosimetric verification of Volumetric Modulated Arc Therapy (VMAT) prostate treatments by an EPID gantry angle-resolved data acquisition, throught the calculation of patient transmission.

The novel approach is analysing data by dose volume histograms (DVH), that provide information on actual delivered dose to the tumor volume and surrounding critical structures.